U.S. DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION

SUMMARY OF STATE GRANTS FOR MINE MAPPING

Abandoned mines present a number of critical safety issues with respect to active mining operations and surface facilities at mines. MSHA has provided funding to various states to help them address these issues through improved mine map collection, digitizing, geo-referencing, archiving, ground-truthing, validating, and delivery. This effort, in combination with the recently-completed Mine Void Detection Demonstration Projects should enhance the tools and information available to mine operators for locating and addressing mine voids and the associated risks.

Between 1997 and 2000, the mining industry experienced four notable incidents where large volumes of coal processing waste slurry retained in impoundments broke through inadequate barriers of soil and rock, passed through mines, and discharged into adjacent watersheds. The breakthrough which occurred at Martin County Coal in Kentucky, the largest of these incidents, resulted in the unplanned release of more than 300 million gallons of coal waste slurry and caused substantial environmental and property damage.

The Mine Safety and Health Administration is responsible for regulating 2,254 impoundments and dams associated with the mining industry. Immediately after the Martin County breakthrough it was determined that many existing coal-mining related impoundments had been built over or adjacent to coal mine workings. MSHA worked with the industry to find engineering solutions to the associated risks.

As a result of the Martin County breakthrough, the United States Congress funded a study through the National Academy of Science's National Research Council, which formed the Committee on Coal Waste Impoundments. The committee ultimately published a report in 2001 titled "Coal Waste Impoundments: Risks, Responses and Alternatives." Among various other things, the Council recommended *"Implementing a coordinated and assertive approach to collecting and archiving mine maps."* and *"Scanning paper copies of mine maps into electronic data files upon receipt."*

On July 24, 2002, the mine inundation and dramatic rescue at the Quecreek #1 Mine in Pennsylvania drew worldwide attention to the problem of abandoned underground mines. In that instance, miners at the Quecreek Mine accidentally cut into flooded abandoned workings of an adjacent mine causing an inundation of the active mine. Nine miners narrowly escaped while nine others remained trapped underground for 77 hours before being rescued. The Quecreek accident was a dramatic example of an all-to-frequent problem. From 1995-2002, mine operators had reported 181 mine inundations, 107 of which were unplanned cut-throughs resulting in water inundation.

The mine inundation and impoundment breakthrough problems share one element in common. They were all the result of unavailable, incomplete, or inaccurate mine maps, and/or inadequate characterization of the subsurface conditions above or adjacent to the mines. Hence, the first

step in preventing such problems is to accurately assess the location and extent of any abandoned underground mines in the area of interest.

There are approximately 300,000 abandoned mines located throughout the Appalachians. Other areas of the country have similar concerns. Primarily as a result of the era when these mines were abandoned, a high percentage are inaccurately or incompletely mapped. Old maps may be unavailable or illegible. In many instances, mine maps have also proven not to be accurate, particularly in the final cut near the outcrop. This area is generally not bolted, so it is not accessible for surveying. Therefore, the extents may only be estimated in these areas, and shown on the maps with dotted lines, indicating uncertainty. Therefore, mine operators and engineers must be diligent in searching for old maps and verifying their accuracy when any uncertainty exists which could adversely affect the safety of miners.

In recognition of the problems involving mine maps, the United States Congress appropriated $10M to MSHA for *"Digitizing mine maps and developing technologies to detect mine voids, through contracts, grants, or other arrangements."* Approximately $3.9M was allocated through state grants to establish programs for digitizing underground maps for abandoned mines and making them available digitally to the public. The funds were distributed as follows:

West Virginia	$1.2 Million
Kentucky	$1 Million
Pennsylvania	$1 Million
Virginia	$317,000
Ohio	$52,000
Utah	$52,000
Illinois	$52,000
Indiana	$52,000
Colorado	$51,000
Alabama	$51,000
Maryland	$50,000
New Mexico	$50,000
New York	$25,000

The states used this money to develop and enhance systems for collecting, digitizing, geo-referencing, archiving, ground-truthing, validating, and delivering mine maps, according to defined needs of each individual state. The progress of each state was presented during meetings on "Underground Mine Mapping" held in Louisville, Kentucky from October 15-16, 2003 and Pittsburgh, Pennsylvania, on June 1-2, 2005. The meetings were attended by representatives of various state and federal programs. Since that time, the states have continued to collect and digitize maps.

We have contacted the state grant recipients and requested a brief update on the results of their activities. Substantial progress has been made. As a result of the MSHA funding, a framework is in place for continued improvements. Many of the states report that efforts are ongoing, with funding from other sources. The information contained on this website is based primarily on information provided by the individual state investigators. Links are provided where users can

obtain further information directly from the state agencies regarding their past and ongoing efforts. Users should consult the state archives, as well as exhausting all other sources of information, when planning important projects in areas of possible abandoned mines. Users should also be aware that the availability and reliability of mine maps can be limited, and it may be necessary to conduct further field exploration using drilling, geophysical, or other means to confirm the presence or absence of mine voids.

In recognition of this fact, the remaining $6.1M of MSHA funding was allocated to contracts for demonstration projects *"for advancing the current state of technology in detecting underground mine voids."* In 2004, MSHA issued a "Request for Proposals" seeking sources to conduct demonstration projects involving methods to locate mine workings. MSHA subsequently received 58 proposals from 23 different sources including universities, government entities, and private contractors. The proposals were thoroughly reviewed by teams consisting of MSHA engineers, geophysicists from the U.S. Army Corps of Engineers' Geophysical Branch, consulting geophysicists, and university professors of geophysics with specific expertise in the methods that they were reviewing. The reviews focused on the technical feasibility of the proposed projects and the perceived value to the industry of conducting the demonstration. An objective rating system was developed. Due to the highly specialized nature of the work, MSHA relied heavily on the contracted expert reviewers and advisers to assist with project selection. The projects funded were those determined to show the most promise for accurately locating or detecting mine voids.

Fourteen proposals were ultimately selected for demonstration, covering a broad spectrum of available technologies. The methods funded are generally categorized as follows:

Surface Seismic Reflection (2 demonstrations)
Borehole Seismic Tomography (3 demonstrations)
In-Seam Seismic (with Various Sources) (4 demonstrations)
Electrical Resistivity (1 demonstration)
Time Domain Electromagnetics (1 demonstration)
Look Ahead Radar (1demonstration)
Borehole Radar Tomography (1 demonstration)
Delta Electromagnetic Gradiometry (1 demonstration)

Since it was clear that no individual technology could address the myriad of conditions and problems in the mining industry, MSHA and our contracted experts believed that it was prudent to sponsor a wide variety of techniques.

The specific contractors selected and their projects are listed below:

Colorado School of Mines, Borehole Seismic Tomography
Colorado School of Mines, Borehole Radar Tomography
D'Appolonia Engineering Division of Ground Technology Inc., Electrical Resistivity
D'Appolonia Engineering Division of Ground Technology Inc., TDEM
L.M. Gochioco Associates, Inseam Seismic
L.M. Gochioco Associates, Surface Seismic Reflection

L.M. Gochioco Associates, Vertical Seismic Profiling
Marshall Miller Associates, Inseam Seismic from Outcrop
Pennsylvania State University, Inseam Seismic
Stolar Research Corporation, Delta EM Gradiometer
Stolar Research Corporation, Look-Ahead Radar
Wright State University, Inseam-to-Surface Seismic with Miner Source
Zapata Engineering, Blackhawk Division: High Resolution Seismic Tomography
Zapata Engineering, Blackhawk Division: Crosshole Seismic

The Void Detection Project reports are contained on a companion, single-source website. Users can download individual project reports and MSHA summaries for each of the projects. Users can also request a copy of the reports on CD ROM.

MSHA hopes that the information contained on this and the companion single-source website is useful to the industry when they planning mining operations or mine facilities in the vicinity of existing mines and that their diligent attention to these details ultimately improves the safety of our Nation's miners. Additional information regarding the grants and contracts can be obtained from the following:

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